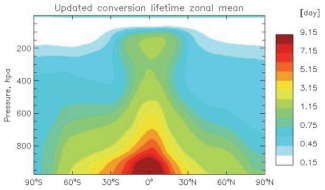
Research Highlight

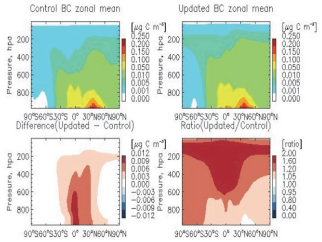
Carbonaceous aerosols that include organic carbon and black carbon have significant implications for both climate and air quality. Their treatment in climate models is one of the largest sources of uncertainty in estimated anthropogenic forcing and, therefore, climate sensitivity. In the current global climate or chemical transport models, a simplified hydrophobic to hydrophilic conversion lifetime (t) for carbonaceous aerosol is generally assumed, which is usually around 1 day. Based on results from recent chamber studies on soot aging, we implemented a new detailed aging mechanism for carbonaceous aerosols in a chemical transport model (GEOS-Chem) where t is affected by local conditions such as ozone concentration and humidity. We evaluate the impact of this aging mechanism on global carbonaceous aerosol distributions using observations.

We find that the aging mechanism results in a global simulated t that has large spatial and temporal variation with the global average value of 4.3 days. The longest conversion times (up to 40 days for the Amazon forests) are found in the tropical areas, reflecting the low ozone concentration and high humidity there. The conversion lifetime generally decreases with altitude due to increases in ozone concentration and decreases in water vapor concentration. The updated aging mechanism has significant implications for model simulations of carbonaceous aerosols and improves the comparison to observations of carbonaceous aerosols. The strongest effects are found for the tropical regions and upper troposphere where the model-simulated concentrations of black carbon and organic carbon increase by up to 0.16µgC/m3 and 0.67µgC/m3, respectively. This updated aging mechanism also leads to increases in model-calculated global burden of black carbon and organic carbon by 31% and 17%, respectively.

Comparisons of the model-simulated BC and OC against observational data show that the updated aging scheme improves model performance, especially in the tropical regions or remote areas. The updated aging scheme also has significant implications for the estimates on carbonaceous aerosols' continental outflow. Our sensitivity model simulations show that the contributions of Asian emissions on background BC and OC in remote regions double with the new aging scheme. The large increases in simulated BC and OC in remote regions with the updated aging scheme imply that the intercontinental transport of BC and OC and the anthropogenic influences on remote regions (such as the polar regions) may be underestimated in previous modeling studies.



Longitudinal and vertical distribution of global zonal mean hydrophobic to hydrophilic conversion time for carbonaceous aerosols with new laboratory aging mechanism.



Impact of new aging mechanism on global zonal mean black carbon distributions relative to control run without it.

Reference(s)

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Working Group(s)

Aerosol Life Cycle